

PLATE I



A



B



C

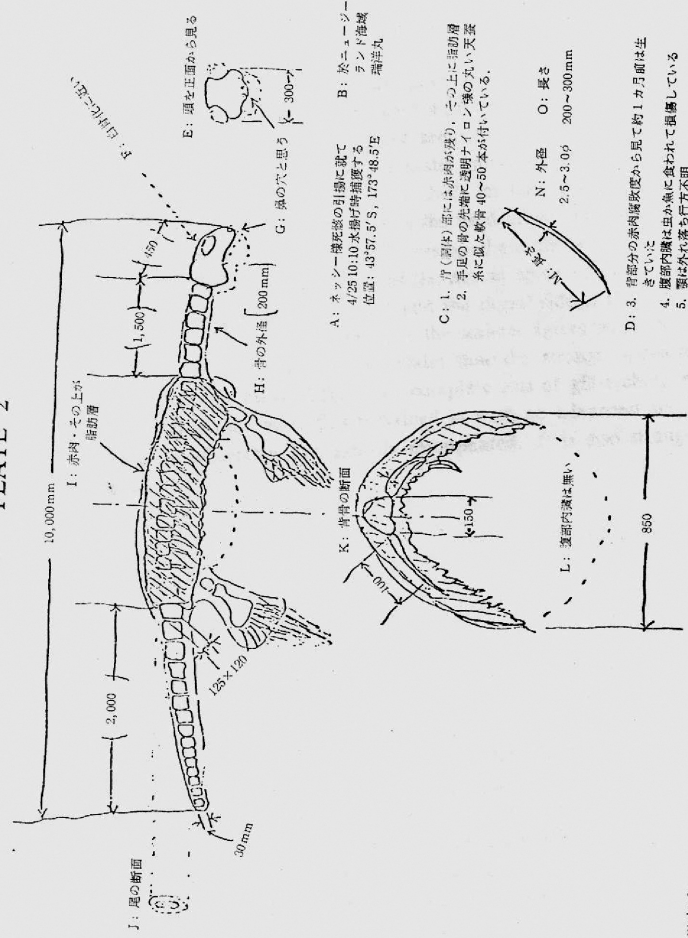


D

1977年4月25日、ニュージーランド南島クライストチャーチ沖 ($43^{\circ}57.5'S$, $173^{\circ}48.5'E$) で、大洋漁業所属のトロール船瑞洋丸 (2,455トン) が収容した未確認動物死体の写真。瑞洋丸船上で矢野道彦氏が撮影したもの。

Photographs of the carcass of an unidentified animal trawled off Christchurch, New Zealand ($43^{\circ}57.5'S$, $173^{\circ}48.5'E$), by the Zuiyomaru of the Taiyo Fishery Co., Ltd., on April 25, 1977. Photos by Michihiko Yano.

PLATE 2



矢野道彦氏による未確認動物死体のスケッチ。見やすくするため、手書きの数字や字句を活字に代えてある。A～Oは英語の説明のためあとから付け加えたもの。

Sketch of the carcass of an unidentified animal by Michihiko Yano. A: Capture of a Nessie-like carcass. Trawled on April 25, 10:00, at 43°57.5'S, 173°48.5'E. B: At the sea off New Zealand; Zuiyo-maru. C: 1. Red muscles remaining on the back of the trunk, overlaid by fat tissues. 2. There are 40~50 pieces of transparent, nylon-like cartilages, egg-shaped in cross section, around the tips of the limbs. D: 3. Judging from the state of putrefaction, the animal may have been alive until about one month before acquisition. 4. Internal organs in the abdomen are damaged, eaten by worms or fish. 5. The lower jaw has been lost. E: Front view of the head. F: Well skeletonized. G: Probably nostrils. H: Diameter of the bone. I: Red muscles; fat layers on them. J: Cross section of the tail. K: Cross section of the back bone. L: No internal organs in the abdomen. N: Length. O: Diameter. Q: Length.

Comparison of the Unidentified Animal with Fossil Animals*

Ikuwo OBATA** and Yoshio TOMODA**

For a discussion of the taxonomy of large marine animals we may not be fully qualified, since one of us, I. Obata, specializes in Cretaceous cephalopods and the other, Y. Tomoda, living and fossil freshwater fishes. Yet we believe our participation in the discussion on a topic of such an obscure nature as the Zuiyo-maru carcass to be of worth, because we may be able to have a broader angle of view than do other specialists.

Information available on the unidentified animal includes a) four kinds of photographs of the carcass taken by Mr. Michihiko Yano (Pl. 1), b) statements of M. Yano and other crewmen of the Zuiyo-maru on the condition of the carcass, c) measurements and a sketch of the carcass made by M. Yano (Pl. 2), and d) 42 pieces of horny fiber collected from the anterior fin.

Of these pieces of information the only material providing evidence is (d). However, the fibers themselves, though they have provided precious data, are too partial material to give the whole picture of the animal. The photographs (a) have high objectivity, but they are indirect materials at best and apt to lead to diverse interpretations. The verbal reports (b) and sketch (c) contain the most vivid descriptions of the whole of the animal. However, these descriptions may have been largely biased or influenced by the observers' preconception.

Part of the references to which investigators attach importance will naturally differ dependent on the fields and means of their study. Making much of the crewmen's long career and rich experiences in the fishing and whaling business, we examine in this note the nature of the unidentified animal utilizing (a) and (b), along with other information, as important references, after making a careful screening of the evidences through interviews with M. Yano.

Analysis of photographs

In the four photographs taken on the deck (Pl. 1), the skull, neck and anterior fin can be readily distinguished. Though the photograph taken from the back (Pl. 1D) appears to show a partly broken right posterior fin overlaying an almost complete right anterior fin, this judgement was denied by Yano, who stated that the fin is the right anterior fin which had an unusual structure in having exposed rays near its base as well as on its edge. That scientists showed the possible affiliation of the animal in various groups of animals, such as the Chelonia, Plesiosauria, Mammalia and Selachii, fluently bespeak the dif-

* Received Sept. 25, 1977

** National Science Museum, Shinjuku-ku, Tokyo 160

difficulty in identifying this animal from the photographs.

Routine identification work for animals is done either on specimens with a complete body surface or on skeleton specimens. Scientists are not familiar with work on decomposed and deformed specimens, in which both external and internal features are difficult to examine. It is then no wonder that the groups of animals suggested by scientists to have the same appearance as that shown in the photographs when they are rotten varied greatly from fish to mammals.

In the photographs a few points attracted our attention. Firstly, in one of the photograph (Pl. 1A), the taut wire rope turns at a white bone (clavicle?). This indicates that the bone was strong. The long bone attached to the presumed clavicle seems to be the scapula. A bone which appears to be the humerus, an element of the supporting bones of the anterior limb, is also seen. It may be possible to assume that these bones had slipped down, as the body became decomposed, from their original positions near the vertebral column. The hollow at the left-side base of the neck may prove such deformation.

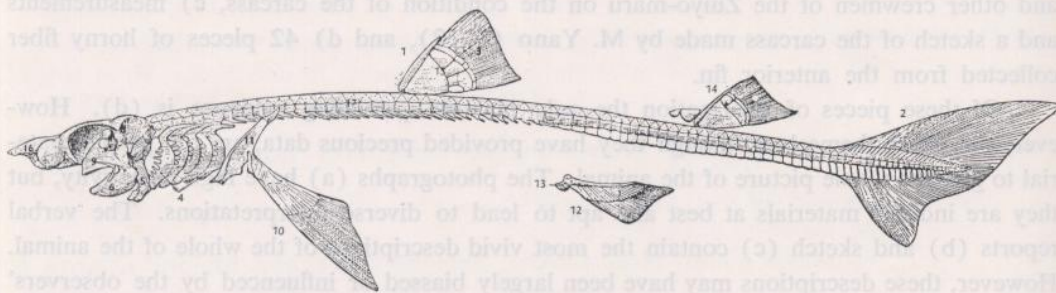


Fig. 1. General skeletal structures of selachians (after Gilbert, S. G., 1973). 1, anterior dorsal fin; 2, caudal fin; 3, ceratotrichia (dermal fin-rays); 4, gill-arches 3 ~ 7; 5, hyoid arch; 6, Meckel's cartilage; 7, orbit; 8, otic capsule; 9, palatoquadrate cartilage; 10, pectoral fin; 11, shoulder girdle; 12, pelvic fin; 13, pelvic girdle; 14, posterior dorsal fin; 15, pterygiophores (cartilaginous fin-rays); 16, rostral cartilage; 17, vertebral column.

Secondly, the anterior limb or fin appears to be articulated at a right angle to the shoulder. Such state of articulation is indicative of a shark (Fig. 1). Whatever this animal may be, the correct names and original positions of these bones cannot be known without expert knowledge of osteology, comparative anatomy and vertebrate paleontology. Examination of the skull is also required, since the structure of skull is an important diagnostic character in the class-rank classification of the Vertebrata. The photographs at hand show ventral views of the cranium, in which depressions and convexities are recognized. Detailed investigation of the ventral surface of the cranium, using magnified photographs, are useful for determining the taxonomic position of the animal (Fig. 2.).

Thirdly, a part of the anterior fin is clearly observed in the photograph showing the rear view of the carcass (Pl. 1D). Several radiator-like white substances are seen in the cross section of a part of the fin, and there are 'horny fibers' exposed at the distal margin of the fin.

Lastly, the photograph (Pl. 1C) shows the slender neck part connected to the high,

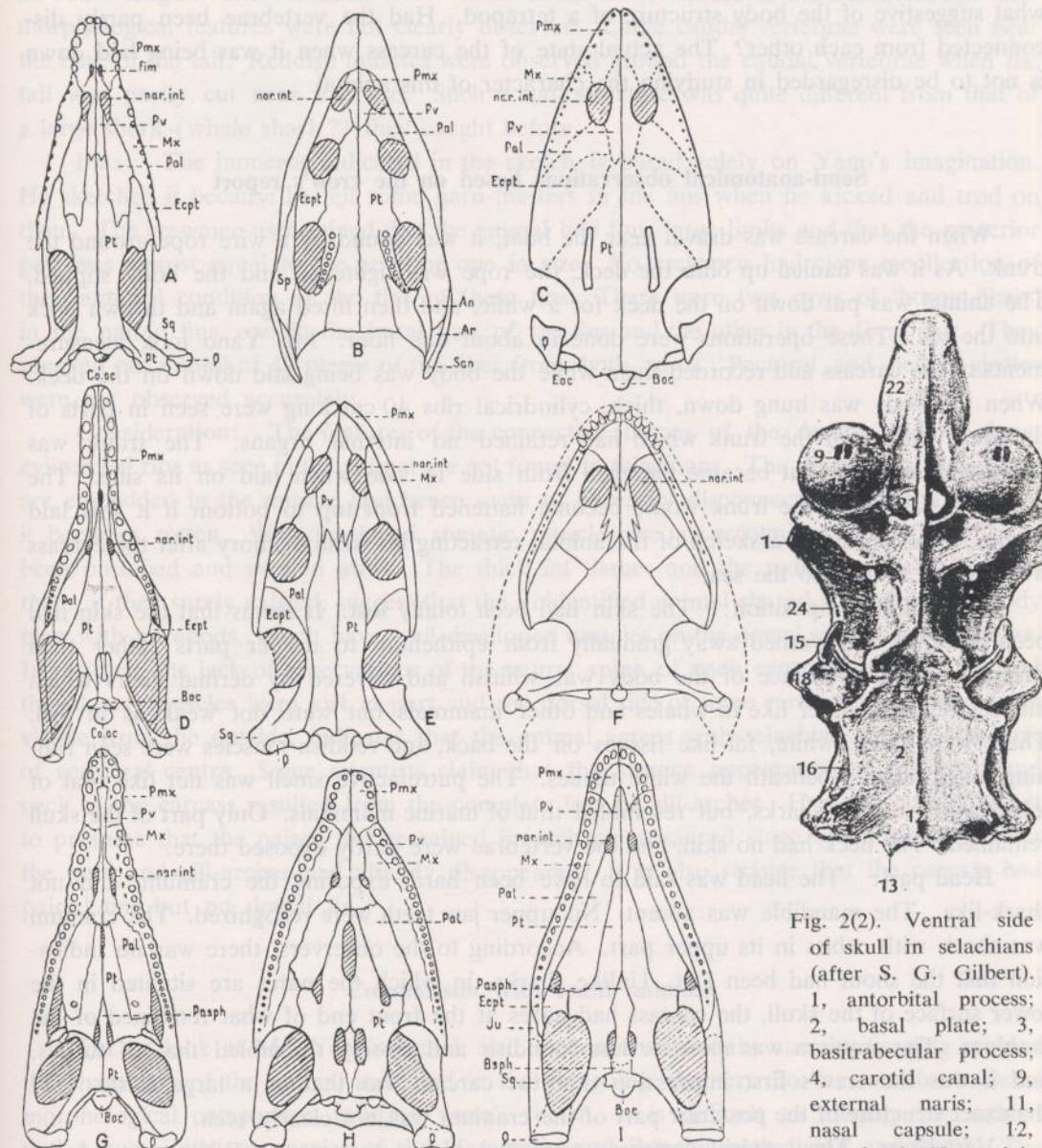


Fig. 2(1). Ventral side of skull in the Mesozoic marine Sauropteria (after Saint-Seine, P., 1955). A, *Nothosaurus* (after Arthaber); B, *Lariosaurus* (after Arthaber); C, *Pachypleurosaurus* (after Zangerl); D, *Pistosaurus* (after Arthaber); E, *Neusticosaurus* (after Arthaber); F, *Anarosaurus* (after Jackel); G, *Pliosaurus* (after Andrews); H, *Thaumatosauros* (after Fraas); I, *Plesiosaurus* (after Andrews).

Fig. 2(2). Ventral side of skull in selachians (after S. G. Gilbert). 1, antorbital process; 2, basal plate; 3, basitrabecular process; 4, carotid canal; 9, external naris; 11, nasal capsule; 12, notochord; 13, occipital condyle; 15, optic pedicle; 16, otic capsule; 18, postorbital process; 20, rostral carina; 21, rostral fenestra; 22, rostrum; 24, supraorbital crest.

strong-built trunk and the thin, long tail bending forward. This aspect of the body is somewhat suggestive of the body structure of a tetrapod. Had the vertebrae been partly disconnected from each other? The actual state of the carcass when it was being laid down is not to be disregarded in studying the character of this animal.

Semi-anatomical observations based on the crew's report

When the carcass was drawn near the boat, it was bound by a wire rope around the trunk. As it was hauled up onto the deck, the rope was tightened and the body slipped. The animal was put down on the deck for a while, and then lifted again and thrown back into the sea. These operations were done in about one hour. Mr. Yano took measurements of the carcass and recorded them while the body was being laid down on the deck. When the body was hung down, thick, cylindrical ribs 40 cm long were seen in parts of the inner surface of the trunk which had retained no internal organs. The trunk was bulky and rounded, but became flattened from side to side when laid on its side. The crewmen stated that the trunk would become flattened from top to bottom if it was laid prone. Yano produced a sketch of the animal retracting his fresh memory after the carcass was thrown away into the sea.

State of decomposition: The skin had been totally lost. It seems that the skin had been putrefied and washed away gradually from epithelium to deeper parts rather than stripped off. The surface of the body was whitish and covered by dermal fibers which intersecting each other like in whales and other mammals but were not weak as in fish. There were thick, white, fat-like tissues on the back, and reddish muscles were seen running longitudinally beneath the white tissues. The putrefactive smell was not like that of teleostean fishes or sharks, but resembled that of marine mammals. Only part of the skull remained. The neck had no skin, and the vertebrae were partly exposed there.

Head part: The head was said to have been hard, exposing the cranium, and not shark-like. The mandible was absent. No upper jaw teeth were recognized. The cranium was short, with orbits in its upper part. According to the observers, there was no indication that the snout had been lost. Unlike sharks, in which the nares are situated in the lower surface of the skull, the carcass had nares at the front end of what remained of the cranium. The cranium was more or less roundish and closely resembled that of turtles, and it was the crew's first impression that the carcass was that of a large turtle. Yet the exact structure of the posterior part of the cranium was not clearly seen.

Vertebrae: The cervical vertebrae appeared rather numerous. When one of the crewmen tried to stab in the neck, the knife easily pierced into it and separated the adjacent vertebrae. However, the cervical vertebral centra seemed massive and quadrate when looked from below, though they were not clearly observed on account of rotten matters covering them. Yano sketched from memory seven cervical vertebrae viewed ventrally. Though he did not count the exact number of the vertebrae, it is possible that there were seven or so cervical vertebrae in his compilation, judging from the fact that the neck part measured 1.5 m in length and each of the vertebrae 20 cm in diameter. The tail part was slender and tapering, and differed from that of whales in which the tail is thick throughout

its entire length. The vertebrae were visible in the inner surface of the trunk, though their morphological features were not clearly observed. Large caudal vertebrae were seen near the base of the tail. Reddish muscles were observed around the caudal vertebrae when the tail was partly cut near its base. Such a tail structure was quite different from that of a large shark (whale shark?) they caught before.

Fins: The humerus indicated in the sketch is based solely on Yano's imagination. He sketched it because he felt some hard matters in the fins when he kicked and trod on them. The crewmen ascertained that the animal had four large limbs and that the posterior pair was almost equal to the anterior one in size. No crewmen had clear recollection of the damaged condition of the tips of these fins. There were two rows of 'horny fibers' in the paired fins, one in the basal part of the fins and the other in the distal part. They plucked out a total of 42 pieces of the fiber from both rows. Pectoral and pelvic girdles were not observed accurately.

Consideration: The features of the connective tissues of the dermis and the long, cylindrical ribs as seen in the animal are not found in selachians. The fin bases of selachians are embedded in the muscle and hence seem to be easily disconnected from the body as it becomes rotten. Well-developed somatic muscles are not recognized. They might have been putrefied and washed away. The thick fat tissues and the reddish muscles beneath them, if they surely existed, suggest that the unidentified animal shared a fundamental body plan with tetrapods, which have well-developed muscles on the dorsal side of the vertebrae. In contrast, the lack of observations of the neural spine of each centrum, despite the fact that dorsal muscles were lost in part and the dorsal side of some vertebrae may have been visible from the outside, indicates that the animal agrees with selachians in the structure of vertebral centra. Some scientists claim that the strange appearance of the head and neck of the carcass resulted from the complete loss of gill-arches. However, it is difficult to presume that the paired fins remained in such an advanced stage of putrefaction after the jaws and gill-arches had already disappeared. It is also strange that the carcass had paired fins but no dorsal fin.

Comparison with fossil animals

Let us look at Mr. Yano's sketch and measurements of the carcass, keeping in mind the characters of the animal indicated in the foregoing chapter. So far, on the basis of morphological comparison utilizing Yano's sketch, it is difficult to identify the animal under study with any species of the Mammalia and Selachii both living and fossil. The animal may show some resemblance to the reptilian plesiosaurs which flourished during the Mesozoic Era (Fig. 3). However, the number of cervical vertebrae indicated by Yano is too small for a plesiosaur. Rather, the feature of the neck part is not necessarily inconsistent with that of sharks so far as the number of the cervical vertebrae is concerned. The Plesiosauria include the Plesiosauridae which have small head and long neck and the Pliosauridae which possess large head and short neck (Fig. 4.). Even in the latter group the cervical vertebrae number at least 13. If the unidentified animal were a plesiosaur, it would have paired fins with the characteristic five rows of phalanges. But

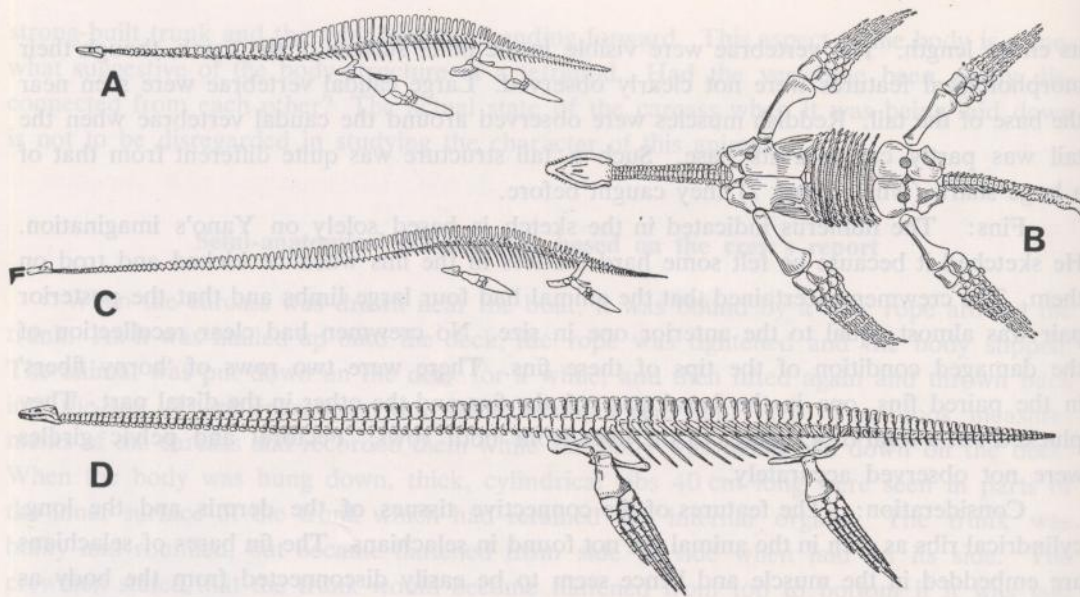


Fig. 3. Mesozoic plesiosaurs. A, *Thaumatosaurus* (after Williston); B, *Microcleidus* (after Watson); C, *Elasmosaurus* (after Watson); D, *Hydrotherosaurus* (after Welles).

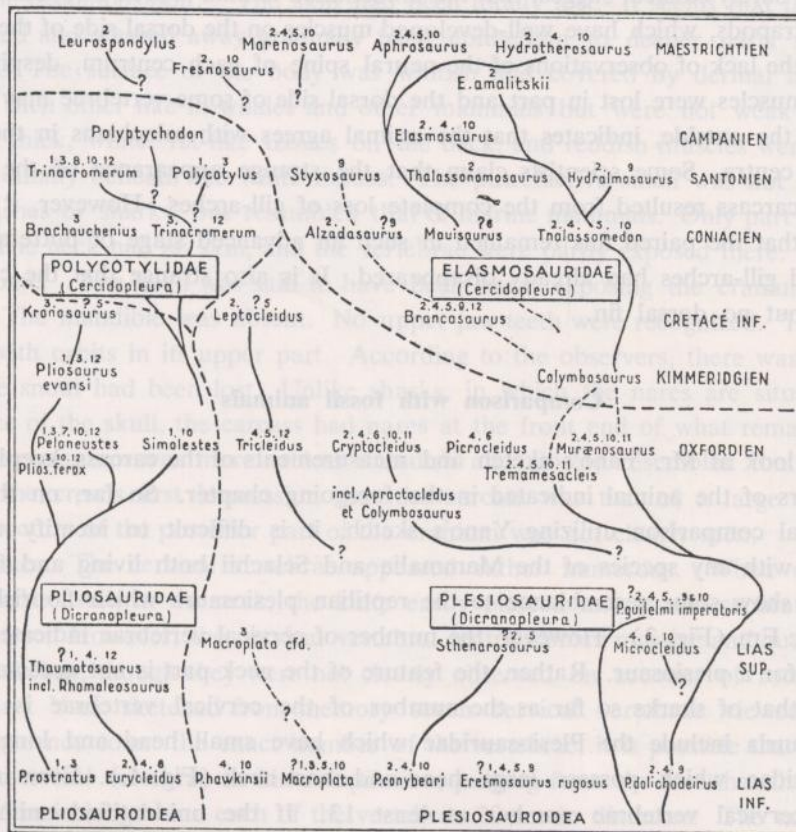


Fig. 4. Phylogeny of the Jurassic and Cretaceous Plesiosauria (after Welles).

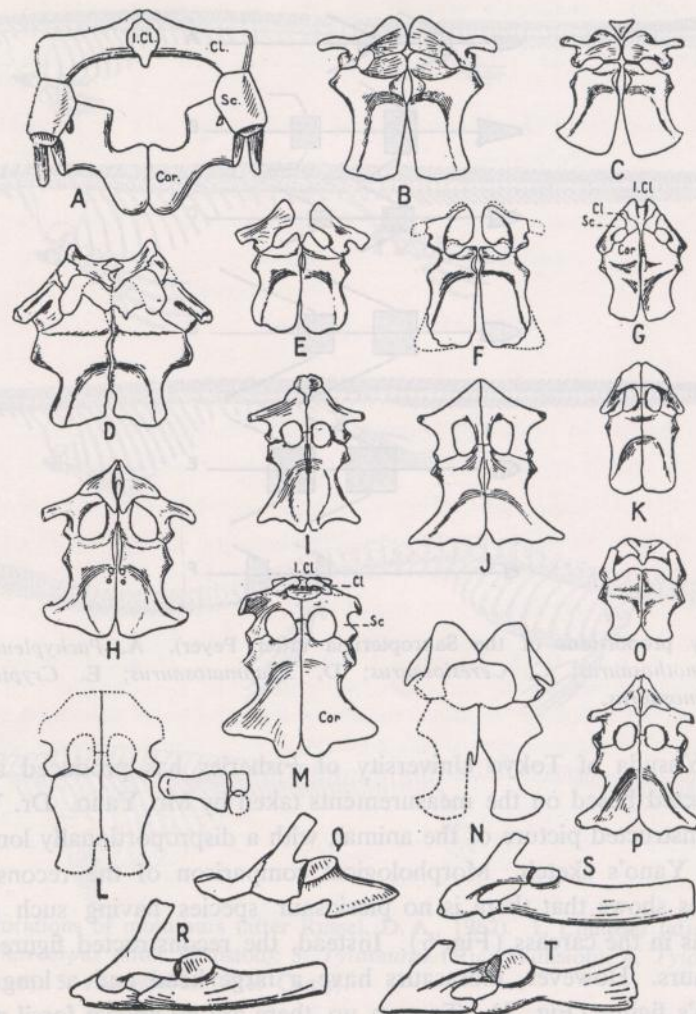


Fig. 5. Sterna of fossil marine reptiles (after Pierre de Saint-Seine, 1955). A, *Nothosaurus*; B, *Pliosaurus*; C, *Peloneustes*; D, *Thaumatosauros*; E, *Simolestes*; F, *Kronosaurus*; G, *Plesiosaurus*; H, *Trinacromerum*; I, *Muraenosaurus*; J, *Colymbosaurus*; K, *Microcleidus*; L, *Elasmosaurus*; M, *Tricleidus*; N, *Hydrotherosaurus*; O, *Sthenarosaurus*; P, *Cryptocleidus*; Q~T, lateral view (left side); Q, *Nothosaurus*; R, *Plesiosaurus*; S, *Microcleidus*; T, *Colymbosaurus*. A, L, Q, T, after Watson; B, K, O, P, after White; M, after Andrews; N, after Welles.

phalanges were not observed in the carcass. A structure like the horny fiber of the fins is found in selachians but not in marine reptiles. It is therefore no wonder that one may assume the animal to be a shark (skates and rays have no horny fin-rays). It is impossible to determine whether this animal is a plesiosaur or not, for we have no accurate knowledge on its skull, sternum and sacrum, all of which are important characters for the identification of plesiosaurs (Fig. 5). Had we even a tooth, it would allow us to approach the animal's exact taxonomic position to the order, generic or even specific level.

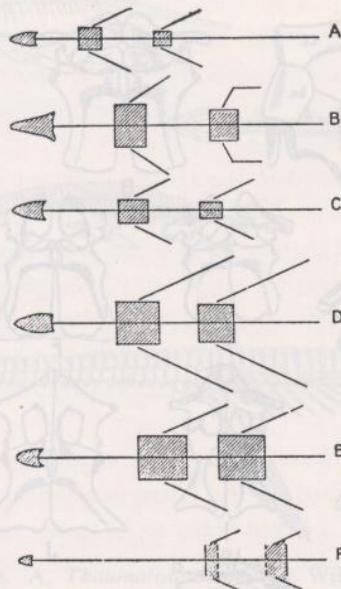


Fig. 6. Body proportions of the Sauropteria (after Peyer). A, *Pachypleurosaurus*; B, *Paranothosaurus*; C, *Ceresiosaurus*; D, *Thaumatosaurus*; E, *Cryptocleidus*; F, *Elasmosaurus*.

Dr. Fujio Yasuda of Tokyo University of Fisheries has produced a figure of the animal reconstructed based on the measurements taken by Mr. Yano. Dr. Yasuda pointed out that the reconstructed picture of the animal, with a disproportionately long trunk, differed greatly from Yano's sketch. Morphological comparison of the reconstructed animal with fossil reptiles shows that there is no plesiosaur species having such proportions of neck and trunk as in the carcass (Fig. 6). Instead, the reconstructed figure somewhat approaches mosasaurs. However, mosasaurs have a large head and a long tail compared with Dr. Yasuda's figure (Fig. 7). To sum up, there are no known fossil reptilian species which agree with the animal under investigation.

The results of analysis of the amino-acid composition of the horny fibers from the anterior fin provided strong support to the opinion that the animal was a species of shark. However, no chemical substances have thus far provided to be truly diagnostic for the classification of higher taxa of vertebrates, in spite of the modern biologists and paleontologists' eager desire to utilize chemical characteristics as clues to investigate animal phylogeny. As to the amino-acid composition under discussion, we have been informed that comparative studies of some groups of animals showed the existence of many amino acids common to all groups dealt with. It may be that qualitative data are not very useful for the discussion of phylogenetic relationships of animals. It is stated that some biochemists intend just to increase knowledge on the ratio of each amino-acid composition in various animals.

In this connection the analysis of chondroitin sulphuric acid in animals recently devised by Dr. Tatsuya Yamagata has shown that the components differ between groups of

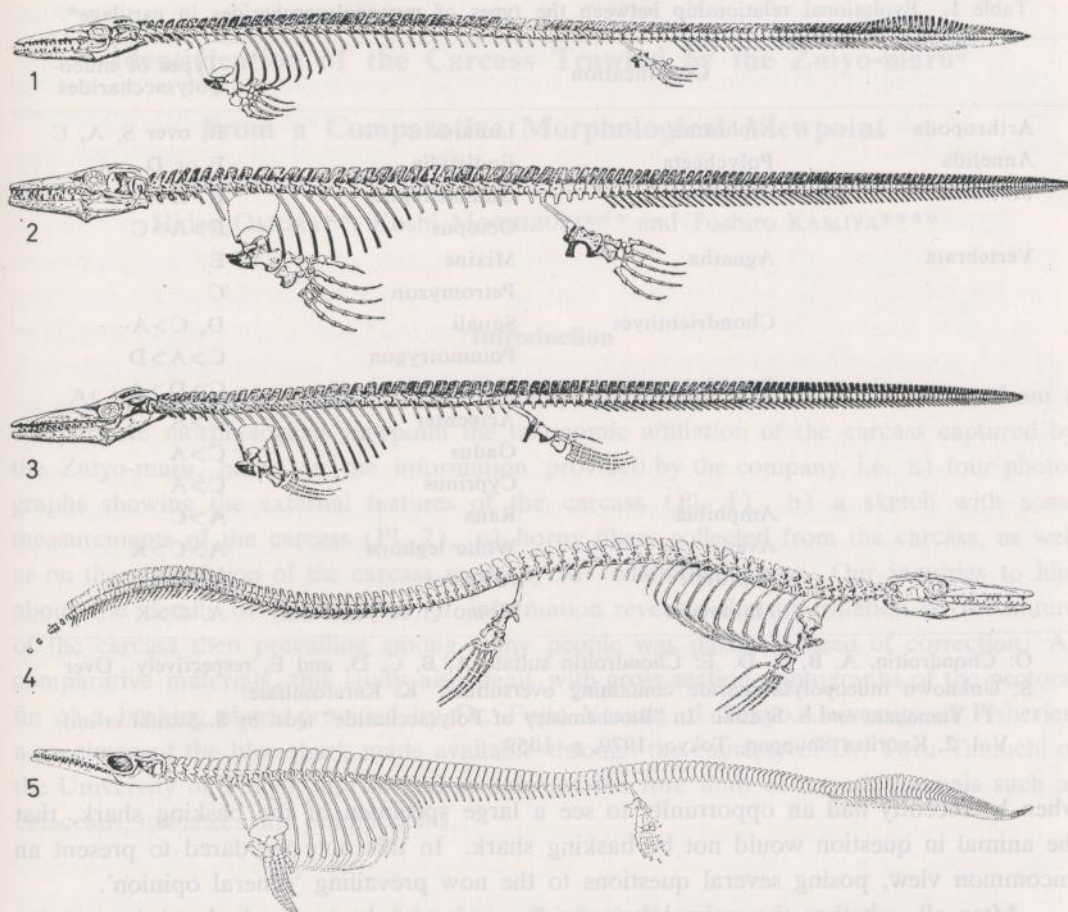


Fig. 7. Restorations of mosasaurs (after Russel, D. A., 1967). 1, *Clidastes* (after Williston); 2, *Platecarpus* (after Williston); 3, *Tylosaurus* (after Williston); 4, *Tylosaurus* (after Osborn); 5, *Plotosaurus* (after Camp).

animals (Table 1). This method will make a great contribution toward the phylogenetic study of vertebrates. At the advice of Dr. Fujio Egami, Mitsubishi Kasei Institute of Life Science, we had Dr. Yamagata analyze 38 mg of dried horny fiber. From the sample 38 mg in dry weight, the presence of 38 m μ moles of uronic acid was detected. This suggests the occurrence of mucopolysaccharide, but the scanty amount of the sample available has not permitted to verify its presence in the horny fiber.

Concluding Remarks

There is still no decisive evidence to determine whether the animal in question was a shark or an undescribed reptile. General opinion favors identification as a shark. A possible method to approach a more accurate identification may be to focus on the basking shark, *Cetorhinus maximus*, which occurs in the cold waters of the Northern hemisphere. Yet a biologist who is inclined to the 'shark concept' told us that he had an impression,

Table 1. Evolutional relationship between the types of mucopolysaccharides in cartilage*.

Classification			Types of mucopolysaccharides
Arthropoda	Xiphosura	Limulus	B, over S, A, C
Annelida	Polychaeta	Eudistylia	E or D
Mollusca	Cephalopoda	Ommastrephes	E>A>C
		Octopus	E>A>C
Vertebrata	Agnatha	Mixine	E
		Petromyzon	C
	Chondrichthyes	Squali	D, C>A
		Potamotrygon	C>A>D
	Osteichthyes	Coelacanth	C>D>A
		Acipenser	C>A
		Gadus	C>A
		Cyprinus	C>A
		Rana	A>C
	Aves	White leghorn	A>C>K
	Reptilia	Alligator	A>C>K
	Mammalia	Homo (1, 10 years old)	A, C>K

O: Chondroitin, A, B, C, D. E: Chondroitin sulfate A, B, C, D, and E, respectively. Over S: Unknown mucopolysaccharide containing oversulfate. K: Keratosulfate.

* T. Yamagata and S. Suzuki: In "Biochemistry of Polysaccharide" (eds. by S. Suzuki *et al.*) Vol. 2, Kyoritsu Shuppan, Tokyo, 1970, p. 1059.

when he recently had an opportunity to see a large specimen of the basking shark, that the animal in question would not be basking shark. In this note we dared to present an uncommon view, posing several questions to the now prevailing 'general opinion'.

After all, whether the animal belongs to a group of sharks or whether it is a marine reptile, we do not know any genera or species that agree with it.

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